THURSDAY, AUGUST 28, 1884

THE "ENCYCLOPÆDIA BRITANNICA"

The Encyclopædia Britannica. Ninth Edition. Vol. XVII. Mot–Orm. (Edinburgh: A. and C. Black, 1884.)

THE present volume of the "Britannica" contains an unusual number of articles of moderate length but of great importance. Among them are numerous articles of scientific interest, and of these we note especially the following:—

The article *Optics*, by Lord Rayleigh, is so good that it is to be regretted that considerations of space had to be attended to. The subject is one which has hitherto been presented in a form somewhat repulsive to the student; and the writer, who has contrived to make even *Primary and Secondary Focal Lines* attractive as well as interesting, deserves high credit. The general subject of Geometrical Optics had already been sketched in the article *Light*, so that the present article deals, almost exclusively, with the second (and sometimes higher) approximations. But Lord Rayleigh has not confined himself to the postulates of that science; he has freely availed himself of the principles of the wave-theory, whenever they were required to simplify a demonstration or to explain a result. And he intersperses, here and there, hints as to the easier methods of exhibiting and testing the results of theory, hints which will be of great advantage to the student.

Commencing with the theorem that a set of rays, originally perpendicular to a surface, can, after any number of reflections and ordinary refractions, be cut orthogonally by another surface, the author develops generally the properties of Caustics and Focal Lines. He then proceeds to apply these properties to prisms, mirrors, and lenses. The practical adjustment of the collimating and observing telescopes for spectroscopic work, and the accurate measurement of refractive indices are described. Here we have some interesting remarks on the reasons for employing the position of minimum deviation in the observation of spectral lines. Next we have the formation of a pure spectrum, specially for the purpose of securing a visual field uniformly illuminated with homogeneous light. This leads to a general sketch of the methods and results of von Helmholtz and Clerk-Maxwell with regard to compound colours. Then we have a discussion of Spherical and Chromatic Aberration, with some brief but highly practical remarks on the construction of achromatic and aplanatic lenses for different purposes. Stokes' important results as to the secondary spectrum are here given with some detail; and the methods of Foucault and Töppler for detecting slight defects of figure, or slight irregularities of refractive index, are explained. Next come the important questions of the brightness of an image, and the *resolving power* of an optical instrument. The limits to resolving power, with the important difference, in this respect, between the telescope and the microscope, are well, but only too briefly, given:—and we have also a short *résumé* of the author's own important discussion of the same question for spectroscopes and gratings. We conclude with the remark, which has been forced on us at almost every paragraph, that while brevity is often a most desirable virtue, it is one whose exercise should be permitted only to those (no doubt the majority) who have nothing to say. Lord Rayleigh would do a great service to science if, taking the present essay as a skeleton, he would develop it into a handy volume.

Prof. Cayley handles the subject of Numbers, from the mathematician's point of view, in two compact articles. That on the *Partition of Numbers*, which is little more than explanatory of the term, we pass over. That on the *Theory of Numbers* is a very carefully written account of the past condition and present position of a subject, "which, originating with Euclid, has in modern times, in the hands of Legendre, Gauss, Lejeune-Dirichlet, Kummer, Kronecker, and others [we may interpolate the names of Cayley, Sylvester, and Henry Smith], been developed into a most extensive and interesting branch of mathematics." The branch is well known to be one of limited interest, for does not De Morgan write that the subject is an isolated part of mathematics, which may be taken up or not at the choice of the student? "It may possibly at some future time be connected with ordinary analysis; that is to say, the determination of the *integer* solutions of a set of equations may not be so distinct a thing from that of a mere solution, integer or not, as it is at present." The author distinguishes between the ordinary (or simplex) theory and the various complex theories. "In any theory, ordinary or complex, we have a first part, which has been termed the theory of congruences; a second part, the theory of homogeneous forms; and a third part, comprising those miscellaneous investigations which do not come properly under either of the foregoing heads." The details are too technical for these columns, but the *résumé* of results is drawn up in a manner likely to be most useful to a student, as it clearly indicates the present condition of matters, being brought down to the very latest date by a master who has done good work in this very direction. There are a few typographical inaccuracies; besides we note the following trifling (we think) oversights:—In Article 15 it is said: "If p is not a prime number, then $1, 2, 3 \ldots (p-1) \equiv 0 \pmod{p}$,"—surely it should be added, "except when $p = 4$"; in Art. 16, line 13, last bracket, for $x - 3$ read $x - 4$; in Art. 19, lines 9, 10, interchange 11 and 17; in Art. 20, line 15, should not 13 and 35 be relegated to the next line? The whole article is so carefully printed that we have thought it not out of place to point out these oversights.

Capt. Moriarty's reputation as a practical navigator has given an unusual interest to the article on *Navigation*, in which he may have been expected to impart to others the trick of his own skill. We must confess to a certain amount of disappointment. The essay is well enough, but it is not what we expected; not what, we still think, we had a right to expect. It is in fact little more than a short elementary treatise on the subject, comprising some of the simpler and more familiar problems, but taking little note of the more exact or more convenient methods which are often required, not perhaps for the daily determination of a ship's position at sea, but for the checking

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of the chronometers and compasses, or for the more certain guidance of the vessel when in with the land. And for an account of such the "Encyclopædia" is, we conceive, the proper place: for it is not a work addressed to a youngster learning for the first time how to rough out a course and distance, or to work a meridian altitude or chronometer; but rather to the general reader wishing to gain some insight into the methods in use, or to the adept who is desirous of a ready reference to those branches of the subject which do not come within the scope of the ordinary text-books.

It is thus that we do not agree with Capt. Moriarty in the disparagement of lunars, which he would relegate altogether to the examination room; the excellence of chronometers in the present day renders—he seems to say—lunars of no practical use; and holding this opinion, his notice of the problem is incomplete, and certainly very unpractical. But Sir Charles Shadwell, whose scientific knowledge of the subject is at least equal to that of Capt. Moriarty, has within these last three years pointed out ("Notes on the Reduction of Lunar Observations," Potter, 1881) that the lunar method is the only one which gives the seaman an independent astronomical solution of the problem of finding longitude at sea. "Chronometers," he says, "may fail, or go astray; accident or carelessness may neglect to wind them up; errors may have been committed in determining or applying their rates, which may not have been discovered till too late to rectify them. In these dilemmas, the sole remedy available for pointing out the real position of the ship in longitude, is a lunar observation." Capt. Moriarty presumably thinks that the rarity of such "dilemmas" renders them of no practical importance: that they do occur, however, is within the cognisance of every navigator; but we fear that under the influence of teaching such as this, the skill to get out of the dilemma in a masterly manner is rapidly becoming scarce: for, as Sir Charles Shadwell has well said, "Confidence in the hour of uncertainty cannot be improvised for the occasion; it can only be the result of habitual practice." We venture therefore to protest most earnestly against the pernicious doctrine to which Capt. Moriarty has lent the sanction of his name. If it is worth a ship's while to carry the cumbrous and costly array of masts and rigging as a stand-by in the event of the huge and powerful engines being disabled, it is surely at least equally worth while to carry the handy and inexpensive skill to observe and compute a lunar, as a check on the very delicate machinery of a chronometer.

In speaking of these, the most exact of all observations with the sextant, we may call attention to the very insidious error which arises from false centering, and which is much more common than is generally understood. To detect this and find the corrections for it, Capt. Moriarty recommends the taking and computing a number of equal altitudes, comparing the error of chronometer so found with the known error of chronometer. This method is excessively laborious, but may be shortened somewhat by the construction of a curve of error, as Capt. Moriarty has described. There is also the danger, which he has omitted to notice, of the whole work going round in a vicious circle; of first determining the error of chronometer by a faulty sextant, and of then using that error to correct the sextant. Capt. Moriarty appears not to know, or has at any rate neglected to point out, that, for an almost nominal fee, sextants can be tested at Kew by a specially constructed apparatus, the invention (we believe) of Mr. Francis Galton. Many men buy a sextant with as little care as they would buy a gridiron; but no one who means to use his sextant for purposes of exact navigation should think of concluding the purchase without getting a satisfactory Kew certificate with it. If he does, he richly deserves all the trouble and annoyance which the neglect of this very simple precaution may entail.

Perhaps the best section of Capt. Moriarty's article is that in which he has treated of the modern application of what is commonly known as Sumner's method of determining a ship's position; what he says on this subject is admirable; we can only wish that he had devoted a little more space to it, and given it a full development; for the theory and the practical use of lines of equal altitude are, as yet, neither sufficiently understood nor attended to by navigators. It would, for instance, have been well to have called attention to the very exceptional value of Venus for these observations; and to the many special cases which arise when the bearing of a distant peak can be taken. In conclusion, we would heartily endorse Capt. Moriarty's commendation of Raper's "Practice of Navigation." It is, beyond question, the best practical work which has yet appeared, and we cannot but express our regret that neither in the Royal Navy nor in the Merchant Service, are its merits properly recognised. The text-book commonly used in the Navy is Inman's, as edited by Jeans; that used in the Mercantile Marine is Norie's. Either of them is very far inferior, as a practical work, to Raper; but the difficulty of changing an established text-book has hitherto been found insuperable.

LETTERS TO THE EDITOR

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[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Electric Light for Lighthouses

In your interesting article on the experiments on lighthouse illumination now in progress at the South Foreland (p. 362) the writer alludes to the remarkable quenching influence of even a light mist on the electric light as compared with either gas or oil lights, and suggests that the smaller area of the illuminating centre in the case of electricity may have something to do with the matter.

Apart from this, however, selective absorption by water vapour must play an important part, and a great deal must depend on the colour of the beam; that is to say, the proportion of different rays combined in it.

MM. Janssen, Ångström, and others have shown that vapour of water in the atmosphere reduces the intensity of the violet end of the spectrum in a general manner and the red end in a more special manner. An examination of Ångström's map of the telluric lines in the solar spectrum (see Schellen's "Spectrum Analysis," Huggins' translation, Fig. 95, p. 264) will show that, while the extreme red and all the blue ends of the spectrum are much darkened by absorption lines, there is a zone from between B and C to δ which is comparatively free from them. This region includes the orange rays, and part of the red and yellow. It is the most luminous part of the spectrum, and contains the rays which will penetrate farthest in a fog. Hence it is that the

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